Climate Liberalism and Decarbonization

Jonathan H. Adler[*]

ABSTRACT: Existing climate policy goals require dramatic and rapid reductions in greenhouse gas ("GHG") emissions. Achieving such reductions within the desired time frame is a tremendous challenge, particularly through conventional regulatory approaches. The conventional approach to environmental problems is to treat such problems as "market failures" that can be corrected by government intervention, such as through regulation. Such approaches are constrained by various sources of government failure that are exacerbated by the scale and scope of the problem. The knowledge problem, administrative transaction costs, and limits on regulatory throughput capacity all hamper the use of traditional regulatory tools to address the problem of climate change. An alternative approach to environmental problems views such problems not as "market failures" but as a failure to have markets in relevant contexts. This approach counsels looking for ways to extend market institutions to cover environmental resources and encourage decentralized, spontaneous responses to price signals as a means of encouraging environmentally desirable behavior. Such approaches have been successful at helping to address many environmental concerns and at encouraging net dematerialization in advanced market economies. These experiences offer lessons for how to more effectively encourage decarbonization and address climate change. Among other things, they suggest a greater emphasis on the conditions that foster innovation and a greater reliance on fiscal tools than on regulatory interventions.

[*] Johan Verheij Memorial Professor of Law and Director of the Coleman P. Burke Center for Environmental Law, Case Western Reserve University School of Law. This Essay is based upon remarks at the 2024 *Iowa Law Review* Symposium on *The Economic Implications of Climate Change*, September 19–20, 2024. The Author thanks Andrew P. Morriss and Seth Oranburg for their comments and Christopher Doyle for research assistance. All errors or inanities are solely the fault of the Author.

INTRODUCTION

Across the globe nations have embraced ambitious greenhouse gas ("GHG") emission reduction targets. These targets are not being met.[1] In the United States and elsewhere, emission reductions are well short of what political leaders have endorsed,[2] and are a ways off from what would be necessary to achieve atmospheric stabilization of greenhouse concentrations.[3] Although the United States has largely decoupled GHG emissions from population and economic growth,[4] this is far less than what is required to achieve atmospheric stabilization.[5] If this broader goal is to be achieved in

1. *See* Annika Stechemesser et al., *Climate Policies that Achieved Major Emission Reductions: Global Evidence from Two Decades*, 385 SCIENCE 884, 884 (2024) (noting that existing mitigation efforts "fall short of the required emission reductions"); Taryn Fransen et al., *Taking Stock of the Implementation Gap in Climate Policy*, 13 NATURE CLIMATE CHANGE 752, 752 (2023) (noting an "ambition gap" and "implementation gap" in climate policies); Shaikh M.S.U. Eskander & Sam Fankhauser, *Reduction in Greenhouse Gas Emissions from National Climate Legislation*, 10 NATURE CLIMATE CHANGE 750, 750 (2020) ("The international community is not on track to meet the climate change objectives of the Paris Agreement.").

2. The United States has previously endorsed aggressive emission reductions, and the Biden Administration increased this commitment in December 2024. *See* Maxine Joselow, *Biden Just Set a New Climate Goal. Trump and Other Obstacles Await*, WASH. POST (Dec. 19, 2024), https://wapo.st/4josgZU (on file with the *Iowa Law Review*). The Trump Administration, on the other hand, has embarked on an aggressive campaign to undo most federal climate change policies. *See, e.g.*, David Gelles, Lisa Friedman & Brad Plumer. *'Full On Fight Club': How Trump Is Crushing U.S. Climate Policy*, N.Y. TIMES (Mar. 2, 2025), https://www.nytimes.com/2025/03/02/climate/trump-us-climate-policy-changes.html (on file with the *Iowa Law Review*); David Gelles & Claire Brown, *Trump's 100 Days of Upending Climate Policy*, N.Y. TIMES (Apr. 29, 2025), https://www.nytimes.com/2025/04/29/climate/trumps-100-days-climate-policy.html (on file with the *Iowa Law Review*). At the time of this writing, it is unclear how successful these efforts will be.

3. Janna Hoppe, Ben Hinder, Ryan Rafaty, Anthony Patt & Michael Grubb, *Three Decades of Climate Mitigation Policy: What Has It Delivered?*, 48 ANN. REV. ENV'T & RES. 615, 616 (2023) ("[C]ountries' nationally determined contributions (NDCs), even if fully implemented, are not sufficient to limit the increase in global average temperatures to 1.5 [degrees] . . . .").

4. *See* HANNAH RITCHIE, NOT THE END OF THE WORLD: HOW WE CAN BE THE FIRST GENERATION TO BUILD A SUSTAINABLE PLANET 82–84 (2024); *see also* Hoppe et al., *supra* note 3, at 617 (noting declines in some nations of energy intensity and carbon intensity).

5. In this regard, it is worth keeping in mind that "the climate will continue to warm until greenhouse gas emissions reach net zero," barring the aggressive use of geoengineering. Matthew G. Burgess, *Five Considerations for Twenty-First Century Climate Policy*, 18 FIU L. REV. 283, 298 (2024); *see also* RICHARD S.J. TOL, CLIMATE ECONOMICS: ECONOMIC ANALYSIS OF CLIMATE, CLIMATE CHANGE, AND CLIMATE POLICY 126–27 (2d. ed. 2019) (noting atmospheric stabilization is the "ultimate target" and that this will require net-zero emissions).

the coming decades, much more is needed.[6] Indeed, so much more is needed that it may require reconsideration of the underlying policy paradigm.[7]

Most climate policies adopted to date have built off of the conventional model of how to diagnose and address environmental concerns. Environmental problems are generally conceived as a consequence of market failure.[8] Existing market institutions, however efficient they may be as a general matter, insufficiently account for certain consequences of economic activity, such as externalities.[9] These failures thus require governmental intervention, in the form of regulation or other measures, to control these externalities or to provide adequate incentives to address environmental concerns.[10]

This conventional approach to environmental problems is that which informs most environmental regulation in the United States. This paradigm has produced some gains, particularly with the first generation of environmental regulations, but this approach also has its limits.[11] Regulatory strategies generally require centralizing information and developing rules or requirements that govern a broad range of private activity and are thus subject to the same sorts of failings as economic central planning (if only more so given the added complexity of environmental concerns).[12]

---

6. Michael Pappas, *The Structure of U.S. Climate Policy*, 83 MD. L. REV. 347, 349 (2024) ("Climate policies need to cut greenhouse gas emissions precipitously, year-over-year in hopes of clinging to the global temperature bands known through human history."). Note, however, that many of the more apocalyptic climate projections are based upon the RCP8.5 scenario which is increasingly viewed as "implausible." *See* Burgess, *supra* note 5, at 286.

7. It is not enough to require marginal reductions in emissions from specific sectors of the economy. Among other things, "policies need to transform fundamental energy and transportation infrastructures." Pappas, *supra* note 6, at 349. Moreover, decarbonization needs to occur consonant with expanding access to reliable energy throughout much of the developing world. *See* VACLAV SMIL, HOW THE WORLD REALLY WORKS 5 (2022).

8. *See infra* notes 18–19 and accompanying text.

9. *See* TOL, *supra* note 5, at 51; *see also infra* notes 19–21 and accompanying text.

10. *See* Tyler Cowen, *Public Goods and Externalities: Old and New Perspectives*, *in* PUBLIC GOODS AND MARKET FAILURES: A CRITICAL EXAMINATION 1, 1 (Tyler Cowen ed., 1992) ("The assertion of market failure is probably the most important argument for governmental intervention."). It is worth noting that the existence of pollution or another environmental problem is not necessarily evidence of market failure or a justification for governmental intervention. As Ronald Coase reminds us, some situations identified "as requiring corrective governmental action is, in fact, often the result of governmental action." R.H. COASE, THE FIRM THE MARKET AND THE LAW 133 (1988).

11. *See infra* note 18 and accompanying text.

12. *See* Richard B. Stewart, *Controlling Environmental Risks Through Environmental Incentives*, 13 COLUM. J. ENV'T L. 153, 154 (1988) ("[T]he system has grown to the point where it amounts to nothing less than a massive effort at Soviet-style central planning of the economy to achieve environmental goals."); Richard B. Stewart, *Models for Environmental Regulation: Central Planning Versus Market-Based Approaches*, 19 B.C. ENV'T AFF. L. REV. 547, 547 (1992) ("The United States, despite its market-based economy, has relied heavily on central planning-style, 'command-and-control' tools to achieve its environmental protection goals.").

These failings are exacerbated by the scale and scope of a "super-wicked" problem like climate change.[13] The knowledge problem, administrative transaction costs, and limits on regulatory throughput capacity all hamper the use of traditional regulatory tools to address the problem of climate change, and few regulatory measures can be relied upon to induce the needed degree of technological innovation.[14]

There is another way of thinking about environmental problems and the sorts of policy measures best to address them. This approach builds off of the observation that the greatest environmental problems are generally observed not where markets are greatest or most efficient, but rather where market institutions are the least comprehensive or complete.[15] As a general rule, throughout the world, those resources and environmental values most incorporated into existing market institutions are those that are managed more sustainably and which received the greatest protection. This leads to the supposition that the problem is not market failure so much as it is a failure to have markets.[16]

If the problem is not market failure but a failure to have markets, then the diagnosis calls for creative ways to expand and reinforce market institutions and augment market incentives. If environmental problems are greatest where market institutions are least present and protected, then the answer may be to expand and enhance such institutions, rather than to regulate and constrain them further. If market forces are not creating sufficient incentives for sustainability, the problem may be that markets are insufficiently robust and do not incorporate all relevant environmental factors.

Dematerialization provides a particularly salient example to illustrate how market institutions can facilitate transformational environmental change. In advanced market economies, resource consumption has been decoupled from economic growth, such that material consumption is actually declining as countries continue to grow.[17] This development has been driven not by regulatory mandates or restraints so much as it is the product of market dynamics, entrepreneurial responses to economic constraints, and permissionless innovation.

Remedying the failure to have markets is easier in some contexts than others. The point of a conceptual paradigm is to help identify the sort of policies that are desired. In the case of climate change, the alternative

13. *See* Richard J. Lazarus, *Super Wicked Problems and Climate Change: Restraining the Present to Liberate the Future*, 94 CORNELL L. REV. 1153, 1159 (2009) ("Scholars long ago characterized a public-policy problem with the kinds of features presented by climate change as a 'wicked problem' that defies resolution because of the enormous interdependencies, uncertainties, circularities, and conflicting stakeholders implicated by any effort to develop a solution.").

14. *See infra* notes 54–62 and accompanying text.

15. *See infra* notes 76–86 and accompanying text.

16. *See infra* notes 76–86 and accompanying text.

17. *See infra* notes 106–10 and accompanying text.

paradigm suggests less attention should be paid to emission reduction requirements or technological mandates, and more to the broader legal environment in which decarbonization can occur. It counsels fewer regulatory mandates and prescriptive regulations, and more attention to reducing the regulatory barriers to innovation and deployment. It counsels greater focus on fiscal tools, and a carbon price in particular, than on how regulators can force desired near-term changes in energy use or GHG emissions.

Part I of this Essay describes the conventional "market failure" paradigm of environmental regulation and discusses why it is ill-suited to address the problem of climate change. Part II outlines the market liberal alternative, which views environmental problems as evidence that markets are insufficient or incomplete. Part III then sketches what a market liberal climate policy agenda might look like before the Essay concludes.

I. THE CONVENTIONAL PARADIGM

The conventional way of conceiving environmental problems is that they are the result of various market failures.[18] However efficient markets may be at encouraging the efficient allocation and use of resources, they fail to adequately account for the environmental consequences of market-driven activity. In one particularly famous and influential formulation, whereas many economic costs and benefits of economic activity are internalized into the prices considered in any given transaction, some environmental effects are not—these effects are externalized (hence the moniker "externalities") and are not adequately accounted for when market actors make decisions.[19]

In the case of climate change, for instance, the conventional approach begins with the observation that when a firm uses energy to produce a widget, the firm gets the benefit of that energy as an input into its production process. As with other production inputs, the more efficiently the firm can use energy, the more it can reduce that aspect of its production costs. Insofar as the energy use results in emissions that threaten public health or contribute to climatic warming, the firm does not bear those costs. Waste residuals from the production process are only internalized if the firm bears the cost of those wastes' management or disposal and is liable for any associated costs imposed on others. If, on the other hand, the byproducts of combustion can be emitted into the ambient air without legal consequence, the costs are externalized to

18. *See* BARRY C. FIELD & MARTHA K. FIELD, ENVIRONMENTAL ECONOMICS: AN INTRODUCTION 66 (7th ed. 2016) (characterizing "market failure" as when market values and social values diverge); Fred L. Smith, Jr., *Markets and the Environment: A Critical Reappraisal*, 13 CONTEMP. ECON. POL'Y 62, 64 (1995) (describing the "market failure" paradigm that underlies much environmental regulation).

19. *See* TOM TIETENBERG, ENVIRONMENTAL AND NATURAL RESOURCE ECONOMICS 45–47 (2d ed. 1988) (describing externalities as a source of market failure); SUSAN E. DUDLEY & JERRY BRITO, REGULATION: A PRIMER 12 (2d ed. 2012) ("Externalities occur when one party's actions impose uncompensated costs or benefits on another party . . . ." (emphasis omitted)).

others, such as those who must breathe the resulting pollution or suffer the consequences of anthropogenic global warming.[20] And because the firm does not bear these costs, it is likely to overconsume the input in question (in this case energy) and under-control the pollution it generates.[21]

Much environmental law and regulation is justified as an effort to internalize or otherwise correct for these sorts of externalities.[22] If the firm is not bearing the costs of its pollution, then governmental intervention is required, if not to directly internalize the environmental costs of the firm's activities by imposing those costs on the firm, then by subjecting the firm to regulatory or other constraints so as to reduce the environmental consequences of the firm's polluting activity. While the theory might best justify efforts to internalize the externalized costs through the imposition of taxes or fees, most environmental measures instead take the form of prescriptive regulations.[23] Thus we get regulations that, depending on the sort of program at issue, mandate or prohibit the use of particular control methods or technologies, place limits on how much firms may emit, or require investments in offsetting activities.[24]

That markets may be imperfect does not mean that regulatory interventions will be superior, particularly since "government regulation has many of the same costs inherent to markets."[25] Adopting regulatory measures

---

20. *See* David Popp, Francesco Vona, Myriam Grégoire-Zawilski & Giovanni Marin, *The Next Wave of Energy Innovation: Which Technologies? Which Skills?*, 18 REV. ENV'T ECON. & POL'Y 45, 48 (2024) ("[W]ithout government intervention, the external harm from burning fossil fuels is not reflected in the costs of fossil fuels.").

21. Burgess, *supra* note 5, at 299 ("Economic activities that emit greenhouse gases primarily benefit the producers and consumers of the activities, while the costs of the emissions via climate change affect everyone in the world. This creates an incentive for producers and consumers to emit more greenhouse gases—and conversely, to mitigate less—than is economically or societally optimal." (footnote omitted)).

Note that from a classical liberal perspective, this imposition of costs on non-emitters is not only inequitable but can also be understood as a rights violation. *See* Jonathan H. Adler, *Taking Property Rights Seriously: The Case of Climate Change*, 26 SOC. PHIL. & POL'Y 296, 311 (2009). *See generally* Billy Christmas, *Pollution and Natural Rights*, *in* CLIMATE LIBERALISM: PERSPECTIVES ON LIBERTY, PROPERTY, AND POLLUTION 25 (Jonathan H. Adler ed., 2023) [hereinafter CLIMATE LIBERALISM] (discussing natural rights theory and how pollution violates those rights).

22. Although often invoked in support of government intervention to address "externalities," Nobel laureate Ronald Coase argued that "the existence of 'externalities' does not imply that there is a *prima facie* case for governmental intervention," and that what may be required is "the facilitating of market transactions" or even "inaction." COASE, *supra* note 10, at 24; *see also id.* at 26 (noting that externalities are "ubiquitous" and "that governmental intervention also has its costs").

23. Stechemesser et al., *supra* note 1, at 886 (noting "command-and-control measures such as emission standards and technology mandates are the most frequently used policies in all sectors except transport").

24. For an exploration of why regulations have been adopted in lieu of taxes, see generally James M. Buchanan & Gordon Tullock, *Polluters' Profits and Political Response: Direct Controls Versus Taxes*, 65 AM. ECON. REV. 139 (1975).

25. TERRY L. ANDERSON & GARY D. LIBECAP, ENVIRONMENTAL MARKETS: A PROPERTY RIGHTS APPROACH 23 (2014).

to address pollution or other environmental problems entails a range of transaction costs, "includ[ing] information costs, distributional effects, and special interest lobbying," such that the existence of imperfect or undesirable market outcomes does not demonstrate the regulatory interventions are desirable.[26] Regulatory programs, and the static economic models upon which they are based, also "oversimplify and ignore the important dynamic forces of entrepreneurship."[27] As noted environmental law scholar Richard Stewart observed well before the federal government had begun pursuing control of GHGs, centralized environmental regulation is inherently limited by "the inability of central planners to gather and process the information needed to write directives appropriately responsive to the diverse and changing conditions of different economic actors; and the failure of central planning commands to provide the necessary incentives and flexibility for environmentally and economically beneficial innovation."[28]

The conventional approach may be fairly workable when there are a discrete number of firms emitting a discrete number of pollutants from a discrete number of sources. Relatively blunt or inefficient measures may still be sufficient to capture low-hanging fruit. Thus, the initial air pollution and water pollution controls embodied in the Clean Air Act ("CAA") and Clean Water Act ("CWA") produced some significant gains (even if they did not clearly result in an acceleration of preexisting trends).[29] But as these relatively easy environmental problems have been solved, the difficulty of using

26. *Id.* at 35. As Coase cautioned, "direct governmental regulations will not necessarily give better results than leaving the problem to be solved by the market or the firm." COASE, *supra* note 10, at 118; *see also* Andrew P. Morriss, *Real People, Real Resources, and Real Choices: The Case for Market Valuation of Water*, 38 TEX. TECH L. REV. 973, 974–75 (2006) ("Markets are far from perfect, of course. But, critiques of markets in general, and critiques of water markets in particular, often conflate dissatisfactions with human nature or other features of society with problems in the market.").

27. Terry L. Anderson, *Dynamic Ecology and Dynamic Economics: The Foundation of Austrian Environmental Economics*, 11 J.L. ECON. & POL'Y 163, 163 (2015).

28. Richard B. Stewart, *United States Environmental Regulation: A Failing Paradigm*, 15 J.L. & COM. 585, 587 (1996); *see also* Anderson, *supra* note 27, at 168 ("Information on which niches are opened and how they should be filled cannot be acquired or ordained from the top down; it requires responses to, what Nobel laureate Friedrich Hayek described as, 'rapid adaptation to changes in the particular circumstances of time and place.'").

29. Key measures of both air pollution and water pollution began declining before enactment of the 1970 Clean Air Act and 1972 Clean Water Act. *See, e.g.*, INDUR M. GOKLANY, CLEARING THE AIR: THE REAL STORY OF THE WAR ON AIR POLLUTION 54–55 (1999); ROBERT W. CRANDALL, CONTROLLING INDUSTRIAL POLLUTION: THE ECONOMICS AND POLITICS OF CLEAN AIR 19 (1983) (noting air pollution control efforts were arguably *more* effective prior to the adoption of federal regulations); David A. Keiser & Joseph S. Shapiro, *Consequences of the Clean Water Act and the Demand for Water Quality*, 134 Q.J. ECON. 349, 373 (2018) ("Dissolved oxygen deficits and the share of waters that are not fishable both decreased almost every year between 1962 and 1990."); A. Myrick Freeman III, *Water Pollution Policy*, *in* PUBLIC POLICIES FOR ENVIRONMENTAL PROTECTION 97, 114 (Paul R. Portney ed., 1990) ("The results of the EPA's first National Water Quality Inventory, conducted in 1973, indicated there had been significant improvements in most major waterways over the preceding decade, at least in regard to organic wastes and bacteria.").

traditional regulatory strategies has multiplied. Policymakers have been vexed with applying this approach to more complicated and dispersed problems. As the number of contributors to a given problem increase, so does the difficulty of correcting for market failures in a centralized fashion. The difficulty of accumulating the necessary amount of information and promulgating the requisite number of rules has taxed the administrative capacity of agencies. Thus, it has been much easier to control point source water pollution than nonpoint source pollution, such as runoff from streets, buildings, and agricultural production.[30] As the low hanging fruit have been picked, the environmental challenges that remain often defy easy administrative fixes.[31]

However satisfied some may be with the traditional approach to environmental problems as applied to traditional pollutants, attempting to apply this model to climate change—and the emission of GHGs in particular—threatens to take these approaches past the breaking point. Indeed, that has been the experience with trying to use the nation's most comprehensive environmental law, the Clean Air Act, as a means of GHG emissions control.[32] While some aspects of the CAA's regulatory scheme that target specific sectors of the economy may work tolerably well for GHG emission control, such as the provisions concerning emissions from automobiles and other mobile sources, the experience with the Environmental Protection Agency's ("EPA") attempt to use the CAA as a GHG emission control system was destined for failure.[33]

---

30. *See* DAVID SCHOENBROD, RICHARD B. STEWART & KATRINA M. WYMAN, BREAKING THE LOGJAM: ENVIRONMENTAL PROTECTION THAT WILL WORK 105 (2010) (noting that nonpoint source pollution represents greatest water quality challenge); Robert W. Adler, *Resilience, Restoration, and Sustainability: Revisiting the Fundamental Principles of the Clean Water Act*, 32 WASH. U. J.L. & POL'Y 139, 162 (2010) (noting CWA permitting system "was designed in and for an industrial society, during which industrial sources of pollution were viewed as the most severe"); RICHARD J. LAZARUS, THE MAKING OF ENVIRONMENTAL LAW 298–305 (2d ed. 2004) (noting that imposing technology based requirements on point sources was easier than ecologically based standards).

31. J.B. Ruhl, *Regulation by Adaptive Management—Is It Possible?*, 7 MINN. J.L. SCI. & TECH. 21, 21 (2005) ("For decades so-called 'command-and-control' regulation has picked the low-hanging fruit . . . ."). On the question of whether existing statutes are obsolete, see SCHOENBROD ET AL., *supra* note 30, at x (noting the "growing obsolescence of our environmental statutes"); Jonathan H. Adler, *The Clean Water Act at 50: Is the Act Obsolete?*, 73 CASE W. RSRV. L. REV. 207, 212–16 (2022).

32. The Clean Air Act was not drafted with GHGs in mind. *See* Arnold W. Reitze, Jr., *Federal Control of Greenhouse Gas Emissions*, 40 ENV'T. L. 1261, 1323 (2010) ("The CAA is not a tool designed to deal with GHG emissions, or more specifically CO_2."). The Supreme Court nonetheless concluded in *Massachusetts v. EPA* that GHGs could be regulated under the Act given its "capacious" definition of what constitutes air pollution. *See* Massachusetts v. EPA, 549 U.S. 497, 532 (2007). Despite this decision, in subsequent cases the Court has been skeptical of efforts to stretch the language of the CAA to accommodate the particular demands of GHG regulation. *See* Util. Air Regul. Grp. v. EPA, 573 U.S. 302, 326 (2014) (rejecting the EPA's "timing and tailoring" rule for the regulation of GHGs); West Virginia v. EPA, 597 U.S. 697, 734–35 (2022) (holding the CAA did not authorize the Clean Power Plan).

33. For a discussion of how federal regulation of GHGs evolved after the *Massachusetts* decision, see Jonathan H. Adler, *Heat Expands All Things: The Proliferation of Greenhouse Gas Regulation Under the Obama Administration*, 34 HARV. J.L. & PUB. POL'Y 421, 423–40 (2011).

One reason it is difficult to use the CAA as a means of addressing climate change is that the core of the Act focuses on ensuring that ambient air quality in metropolitan areas meets federal air quality standards.[34] Under these provisions, the EPA sets national ambient air quality standards ("NAAQS") for criteria air pollutants.[35] States are then required to develop state implementation plans for the achievement of these standards within the state.[36] This approach is appropriate for traditional air pollutants for which it makes sense to talk about ambient concentrations in a particular area where such concentrations may impact the health of local inhabitants. Yet this approach is fundamentally incompatible with the control of pollutants that are dispersed throughout the global atmosphere and for which it makes no sense to speak of local or ambient concentrations.[37]

The source-specific regulatory provisions of the CAA are an even poorer fit for the control of GHG concentrations. These emissions, carbon dioxide in particular, are not emitted from a relatively discrete number of sources in easily measurable and monitorable amounts. Carbon dioxide emissions are, instead, a ubiquitous byproduct of modern civilization. Thus, when the EPA began considering how to apply the CAA to GHG emissions, it soon discovered that its stationary source programs would be overwhelmed by an explosion of permitting applications.[38] Applying the Act's express statutory thresholds that trigger permitting requirements to GHGs would have increased the universe of regulated facilities—and the number of permits that the EPA and state agencies would have to process—more than a hundred-fold.[39]

Specifically, the EPA estimated that the number of facilities required to submit applications under the "Prevention of Significant Deterioration" (PSD) program each year would increase from two hundred eighty to over forty thousand,[40] while the number of facilities subject to the Title V permitting requirements would increase from approximately fifteen thousand to six

34. *See* Union Elec. Co. v. EPA, 427 U.S. 246, 249 (1976) (characterizing provisions requiring state implementation plans to meet NAAQS standards as "[t]he heart of the [CAA]"); *see also* Lisa Heinzerling, *The Clean Air Act and the Constitution*, 20 ST. LOUIS U. PUB. L. REV. 121, 121 (2001) ("The National Ambient Air Quality Standards . . . form the centerpiece of what many consider to be this country's single most important environmental program.").

35. 42 U.S.C. §§ 7408–7409 (2018).

36. *Id.* § 7410.

37. *See* Jonathan B. Wiener, *Think Globally, Act Globally: The Limits of Local Climate Policies*, 155 U. PA. L. REV. 1961, 1966 (2007) ("[N]o state could effectively control its own ambient level of carbon dioxide or other GHGs, because that ambient level is determined by the worldwide concentration of GHGs in the atmosphere.").

38. *See* Adler, *supra* note 33, at 433–34.

39. *See* Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, 74 Fed. Reg. 55292, 55301 (Oct. 27, 2009) [hereinafter GHG Tailoring Rule] (to be codified at 40 C.F.R. parts 51, 52, 70, and 71).

40. *Id.*

million.[41] The resulting influx of permit applications, the EPA concluded, would "paralyze[]"[42] and "overwhelm permitting authorities' administrative resources."[43] Purely to account for the costs and staffing requirements for regulatory agencies would cost over fifteen billion dollars.[44] To address this problem, the EPA proposed rewriting the Act's requirements through regulation, but the Supreme Court concluded the EPA lacked any such authority under the text of the Act.[45]

Relying upon other provisions of the Clean Air Act does not provide a clearer path to stabilizing U.S. concentrations of GHGs. Under section 111, the EPA can adopt "standards of performance" for various source categories of regulated pollutants, including GHGs.[46] But using this approach requires the EPA to go through the full rulemaking process for each source category it seeks to regulate. So although the EPA could potentially achieve significant emission reductions from the power sector, it would have to repeat the full rulemaking process for each category of stationary source emissions, over a period of many years, each of which would represent a shrinking slice of the nation's overall emissions.[47] Whatever is done with the energy sector, there are other sources of emissions that are unlikely to be reduced without substantial technological innovation, including aviation, cement production, and agriculture.[48] Drafting and promulgating regulations governing each sector would take months (if not years) and each would be subject to legal

41. *Id.* at 55295.

42. *Id.* at 55294.

43. *Id.* at 55302.

44. *Id.* Note that this was the EPA's assessment under the Obama Administration. Outside groups, such as the U.S. Chamber of Commerce, presented evidence that, if anything, the EPA was grossly *under*estimating the administrative burden of trying to apply these CAA provisions to GHGs. *See* Adler, *supra* note 33, at 434–35.

45. Util. Air Regul. Grp. v. EPA, 573 U.S. 302, 310–13, 333–34 (2014).

46. 42 U.S.C. § 7411. In *West Virginia v. EPA*, 597 U.S. 697 (2022), the Supreme Court rejected one approach to the regulation of GHGs from power plants under section 111. The Court's decision was based upon the conclusion that the manner of regulation chosen by the EPA was not authorized by Congress. *Id.* at 733–35. It did not conclude, however, that the EPA lacked the authority to regulate GHGs from power plants under this provision. On the *West Virginia* decision more broadly, see generally Jonathan H. Adler, West Virginia v. EPA*: Some Answers About Major Questions*, 2022 CATO SUP. CT. REV. 37 (2022) (discussing the impact of *West Virginia v. EPA* on climate change action).

47. Consider that, globally, electricity accounts for only twenty percent of total final energy consumption, so focusing on decarbonizing electricity will not be remotely enough. *See* INT'L ENERGY AGENCY, KEY WORLD ENERGY STATISTICS 2021, at 34 (Sept. 2021), https://www.iea.org/reports/key-world-energy-statistics-2021/final-consumption [https://perma.cc/G7Z7-GLLP] (reporting electricity accounted for 19.7 percent of world total final energy consumption in 2019).

48. *See* Burgess, *supra* note 5, at 298; *see also* SMIL, *supra* note 7, at 41 (noting "we have no readily deployable commercial-scale alternatives" to the use of fossil fuels for the production of essential resources such as "steel, ammonia, cement, and plastics"); *id.* at 63 (noting the reliance of food production on fossil fuels).

challenge and judicial review, and not every significant source of emissions would even be subject to CAA regulation.[49]

The problem is not merely with the CAA, but with the underlying enterprise of trying to use administrative regulatory process to control emissions of a substance that is so ubiquitous. Adopting legislation expressly authorizing the EPA to adopt GHG regulations would help protect resulting rules from some legal challenges, but it would not do much to reduce the daunting administrative task of proposing and promulgating the myriad regulations that would be required. The so-called CLEAN Future Act, for example, would have required the EPA and other federal agencies to adopt dozens of new regulations within the first two years after its enactment.[50] Earlier climate legislation passed by the House during the Obama Administration (but never passed by the Senate) would have required as many as one hundred and forty-five rulemakings to implement.[51] It is fanciful to think the EPA would be able to fulfill such ambitions, as it is rare for the EPA to issue more than ten major regulations in a single year across all of its program areas.[52] The EPA has only issued more than ten major regulations in a single year twice in the twenty-first century—eleven in 2023 and twenty-four in 2024.[53] On average the EPA has promulgated fewer than six such rules annually since 2001.[54]

The challenge of climate change is not merely of controlling emissions from discrete sources. Decarbonizing the economy—both in the United States and abroad—requires unleashing dramatic technological innovation.[55] "Complete decarbonization of the global economy by 2050 is now conceivable only at the cost of unthinkable global economic retreat, or as a result of extraordinarily rapid transformations relying on near-miraculous technical advances," warns leading energy analyst Vaclav Smil.[56] Yet regulatory mandates

49. For a discussion of the administrative requirements of going through such processes, see Jonathan H. Adler, *The Legal and Administrative Risks of Climate Regulation*, 51 ENV'T. L. REP. 10485, 10489–91 (2021).

50. *See id.* at 10491–93.

51. *See* E. Donald Elliott, *Lessons from Implementing the 1990 CAA Amendments*, 40 ENV'T L. REP. NEWS & ANALYSIS 10592, 10592 (2010).

52. *See EPA Economically Significant Final Rules Published by Presidential Year*, REGUL. STUD. CTR. (Feb. 14, 2025), https://regulatorystudies.columbian.gwu.edu/sites/g/files/zaxdzs4751/files/2024-10/epa_econ_significant_rules_by_presidential_year.pdf [https://perma.cc/N3BS-G482]; *see also* U.S. GOV'T ACCOUNTABILITY OFF., GAO-15-34, ENVIRONMENTAL LITIGATION: IMPACT OF DEADLINE SUITS ON EPA'S RULEMAKING IS LIMITED 9 (2014) (noting that the EPA issued "32 major rules" between May 31, 2008, and June 1, 2013, for an average of 6.4 major rules per year). For more discussion of this point, see Adler, *supra* note 49, at 10486–94.

53. *EPA Economically Significant Final Rules Published by Presidential Year*, *supra* note 52.

54. *Id.*

55. *See* Popp et al., *supra* note 20, at 45 ("The technological challenges of further reducing greenhouse gas emissions are different from the challenges that have been overcome so far.").

56. SMIL, *supra* note 7, at 5–6. Even lesser goals require dramatic innovation. *See* Jae Edmonds et al., *Global Energy System Transitions*, 18 REV. ENV'T ECON. & POL'Y 2, 4 (2024) ("Implementing Paris goals implies a revolutionary transformation of the global energy system.").

are a poor means of spurring technological innovation generally, let alone of fostering industrial transformations. Where such transformations have occurred, they have been driven by market pressures, not dictated by government fiat.

Using traditional regulatory tools to drive technological innovation requires detailed knowledge about the desired course of technological change and what sorts of innovations are likely or foreseeable. Yet government regulators rarely have the necessary information or foresight to drive innovation this way.[57] Although government regulators "can typically assume that *some* amount of improvement over existing technology will always be feasible, it is impossible to know how much."[58] As Arrow et al. observe, "[r]egulators can find it difficult to obtain information about the status of technologies that is accurate enough to allow them to set standards that both can be achieved and will induce real innovation."[59] Even if regulators were to identify a proper target initially, the regulatory process changes so slowly that regulatory standards would be unlikely to keep up with technological change or account for new information.[60] "Innovation is not steady and predictable . . . . It's instead inherently jumpy, uneven, and random."[61]

It is one thing for the government to require (or subsidize) the adoption of a new technology to force its diffusion throughout an industry, but quite another to mandate production or pollution improvements that have yet to be achieved.[62] Government regulators "have a relatively poor record in picking which future technologies will best succeed in achieving a particular objective."[63] This has been as true with regulatory efforts to spur innovation along a certain path as it has been with traditional research subsidies, and for the same reason: Government officials, even those with the benefit of specialized

57. *See* Robert W. Hahn, *Climate Policy: Separating Fact from Fantasy*, 33 HARV. ENV'T L. REV. 557, 580 (2009) ("The regulator typically lacks the kind of information needed to set standards appropriately for forcing innovation."); Gary E. Marchant, *Sustainable Energy Technologies: Ten Lessons from the History of Technology Regulation*, 18 WIDENER L.J. 831, 836 (2009) ("[I]t is difficult to predict the ingenious and creative innovations [scientists and inventors] might develop.").

58. Adam B. Jaffe, Richard G. Newell & Robert N. Stavins, *Environmental Policy and Technological Change*, 22 ENV'T & RES. ECON. 41, 50 (2002).

59. Kenneth J. Arrow et al., *A Statement on the Appropriate Role for Research and Development in Climate Policy*, 6 ECONOMISTS' VOICE 1, 3 (2009).

60. *See* Jaffe et al., *supra* note 58, at 50 ("[W]hile regulators can typically assume that *some* amount of improvement over existing technology will always be feasible, it is impossible to know how much. Standards must either be made unambitious, or else run the risk of being ultimately unachievable, leading to political and economic disruption . . . .").

61. ANDREW MCAFEE, MORE FROM LESS: THE SURPRISING STORY OF HOW WE LEARNED TO PROSPER USING FEWER RESOURCES—AND WHAT HAPPENS NEXT 111 (2019).

62. *See* Hahn, *supra* note 57, at 580 ("Standards may be effective in limited situations where the technological solution is reasonably clear, but they are unlikely to result in major breakthroughs.").

63. Marchant, *supra* note 57, at 836.

technical knowledge, lack the foresight necessary to predict technological progress and the future path of innovation.[64]

There is little empirical evidence that regulations are a reliable method of encouraging technological innovation, particularly revolutionary breakthroughs of the sort necessary to address climate change.[65] What evidence there is suggests that regulatory strategies are more likely to produce incremental innovations than dramatic leaps, and that market-oriented instruments will be more effective than traditional command-and-control regulation.[66] Regulations are more suited to incremental technological change and the diffusion or deployment of preexisting innovations than they are at fostering invention and innovation in the first place.[67] The Clean Air Act's acid rain program, for instance, is widely credited with achieving substantial pollution reductions at a relatively low cost, yet it does not appear to have spurred much invention.[68] The targets imposed under that program were "well within the range of capabilities of existing technology," and thus did more to encourage diffusion than innovation.[69] While California is often heralded for its leading role in developing vehicle emission standards, its early efforts to induce the development of zero-emission vehicles in the 1990s were

64. *See* DEIRDRE NANSEN MCCLOSKEY & ALBERTO MINGARDI, THE MYTH OF THE ENTREPRENEURIAL STATE 42–44 (2020) (noting the bottom-up nature of innovation).

65. *See* Jaffe et al., *supra* note 58, at 55; David E. Adelman, *Climate Change, Federalism, and Promoting Technological Change*, *in* BEYOND ENVIRONMENTAL LAW: POLICY PROPOSALS FOR A BETTER ENVIRONMENTAL FUTURE 199, 209–11 (Alyson C. Flournoy & David M. Driesen eds., 2010). While there is some debate over whether regulations may foster marginal efficiency improvements, such as is suggested by the so-called "Porter Hypothesis," this is distinct from the question of whether regulatory mandates are effective at encouraging technological transformations. *See* Stefan Ambec, Mark A. Cohen, Stewart Elgie & Paul Lanoie, *The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness?*, 7 REV. ENV'T ECON. & POL'Y 2, 16 (2013).

66. *See* Jaffe et al., *supra* note 58, at 61. In this regard, tradable emission permit schemes may not be much better. *See, e.g.*, Margaret R. Taylor, Edward S. Rubin & David A. Hounshell, *Regulation as the Mother of Innovation: The Case of SO_2 Control*, 27 LAW & POL'Y 348, 370 (2005) (finding no evidence emissions trading under the Clean Air Act of 1990 induced greater technological innovation than traditional regulation).

67. *See* Adam B. Jaffe, Richard G. Newell & Robert N. Stavins, *Technological Change and the Environment*, *in* 1 HANDBOOK OF ENVIRONMENTAL ECONOMICS: ENVIRONMENTAL DEGRADATION AND INSTITUTIONAL RESPONSES 461, 464–65 (Karl-Göran Mäler & Jeffrey R. Vincent eds., 2003) (distinguishing between invention, "the first development of a scientifically or technically new product or process;" innovation, "when the new product or process is commercialized" or "made available on the market;" and diffusion, when an innovation becomes "widely available for use in relevant applications through adoption by firms or individuals").

68. *See* David M. Driesen, *An Environmental Competition Statute*, *in* BEYOND ENVIRONMENTAL LAW: POLICY PROPOSALS FOR A BETTER ENVIRONMENTAL FUTURE, *supra* note 65, at 173, 175–76.

69. *See* LEE LANE, AM. ENTER. INST. FOR PUB. POL'Y RSCH., THE GREEN MOVEMENT AND THE CHALLENGE OF CLIMATE CHANGE 3 (2009); *see also* Anne E. Smith, Jeremy Platt & A. Denny Ellerman, *The Costs of Reducing Utility SO_2 Emissions – Not as Low as You Might Think* 14–15 (Ctr. for Energy & Env't Pol'y Rsch., Working Paper No. 98-010, 1998).

a failure.[70] Though once the technology had developed, regulations mandating their purchase became viable.

Not only is regulation a poor means of fostering discovery and innovation, it can actually get in the way, blocking cleaner technologies and discouraging their development. Longer term investments in innovation require credible and stable commitments, which traditional environmental regulation may undermine.[71] Insofar as governmental commitments to future levels of regulation are of "'questionable credibility,'" this diminishes the incentives for innovation that environmental regulations could otherwise provide.[72] The premature imposition of stringent regulatory requirements could actually inhibit or slow the rate of technological innovation. If a regulation embraces a given technological approach to meeting a given target, there is little incentive to develop alternatives or improve upon the technology.[73] As a consequence, "technology-based standards provide the weakest incentives for both abatement technology and output technology innovation."[74]

Yet even performance-based standards can discourage innovation as such standards may be based upon established reference technologies in order to facilitate implementation and enforcement. By increasing the costs of modifying and enhancing existing industrial facilities, and the costs of replacing older, dirtier technologies with newer, cleaner ones, regulatory mandates may work at cross-purposes with the goal of developing less-polluting and less energy-intensive means of production.[75]

---

70. *See* Jonathan H. Adler, *Eyes on a Climate Prize: Rewarding Energy Innovation to Achieve Climate Stabilization*, 35 HARV. ENV'T L. REV. 1, 38–39 (2011) (discussing efforts of the California Air Resources Board to mandate zero-emission vehicles before adequate technologies had been developed).

71. *See* Richard G. Newell, *The Energy Innovation System: A Historical Perspective*, *in* ACCELERATING ENERGY INNOVATION: INSIGHTS FROM MULTIPLE SECTORS 25, 42–44 (Rebecca M. Henderson & Richard G. Newell eds., 2011), https://www.nber.org/chapters/c11747.pdf [https://perma.cc/9A4U-GL52] (noting research showing that changing regulatory conditions and uncertainty can dampen private sector investment in technological innovation).

72. *See* Marchant, *supra* note 57, at 848 (quoting David E. Adelman & Kirsten H. Engel, *Reorienting State Climate Change Policies to Induce Technological Change*, 50 ARIZ. L. REV. 835, 854 (2008)).

73. *See* Jaffe et al., *supra* note 58, at 50; Adam B. Jaffe & Robert N. Stavins, *Dynamic Incentives of Environmental Regulations: The Effects of Alternative Policy Instruments on Technology Diffusion*, 29 J. ENV'T ECON. & MGMT. S-43, S-46 (1995) ("[O]nce a performance standard has been satisfied, there may be little benefit to developing and/or adopting even cleaner technology.").

74. Wesley A. Magat, *The Effects of Environmental Regulation on Innovation*, 43 LAW & CONTEMP. PROBS., Winter–Spring 1979, at 4, 21.

75. There is also some evidence that the timing of regulations may encourage increased utilization of older, dirtier technologies and increase associated emissions in the short-run. *See, e.g.*, Andrew McKinley, Short Circuited: Costly Transitions Under the Clean Air Act 2–3 (Dec. 12, 2024) (unpublished manuscript), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4972091 [https://perma.cc/VCJ3-GWBK].

II. THE MARKET LIBERAL PARADIGM

The conventional regulatory approach to environmental protection is particularly unsuited to addressing the problem of climate change. Centralized regulatory authorities lack the information and the capacity to address the myriad sources of and contributors to GHG emissions, and prescriptive regulations are unlikely to encourage anywhere near the degree of technological innovation necessary to decarbonize the United States, let alone the world. What, then, is the alternative?

Whereas the conventional approach to environmental protection sees markets as a source of environmental harms to be controlled, the classical liberal approach rather sees markets as a key driver of environmental progress. Instead of viewing environmental problems as the result of "market failures," this approach instead views systematic failures to achieve progress toward environmental goals as the result of a failure to have markets—or, more properly, a failure to extend and protect property rights and voluntary exchange to the full range of ecological resources.[76] From this perspective, the role of government is not to identify and address each and every environmental impact of productive activity, but to provide and preserve the underlying institutional framework that protects the persons and property of individuals while allowing people to pursue and advance environmental values.[77]

This market liberal paradigm starts with the observation that markets are the key driver of wealth creation and technological progress. The turn toward market economies has been the preeminent contributor to increases in human welfare and flourishing, whether measured by life expectancy, income, or

76. As Fred Smith has argued, "[r]ather than viewing the world in terms of market failure, we should view the problem of externalities as a *failure to permit markets* and create markets where they do not yet—or no longer—exist." Fred L. Smith, Jr., *Conclusion: Environmental Policy at the Crossroads*, *in* ENVIRONMENTAL POLITICS: PUBLIC COSTS, PRIVATE REWARDS 177, 192 (Michael S. Greve & Fred L. Smith, Jr. eds., 1992); *see also* Mark Pennington, *Liberty, Markets, and Environmental Values: A Hayekian Defense of Free-Market Environmentalism*, 10 INDEP. REV. 39 (2005) ("[F]ree-market environmentalism has demonstrated that environmental problems, far from being the inevitable result of market institutions, are best explained by the *absence* of these very institutions."); Jonathan H. Adler, *Environment*, *in* THE ENCYCLOPEDIA OF LIBERTARIANISM 150, 151 (Ronald Hamowy ed., 2008) ("[L]ibertarian-ism holds that environmental problems are instead the result of the absence of markets.").

77. Most classical liberal work on environmental protection embraces what has been called "free market environmentalism." Representative work in this vein includes the following: ANDERSON & LIBECAP, *supra* note 25; Jonathan H. Adler, *Conservative Principles for Environmental Reform*, 23 DUKE ENV'T L. & POL'Y F. 253 (2013); TERRY L. ANDERSON & DONALD R. LEAL, FREE MARKET ENVIRONMENTALISM (rev. ed. 2001); Jonathan H. Adler, *Free & Green: A New Approach to Environmental Protection*, 24 HARV. J.L. & PUB. POL'Y 653 (2001); Smith, *supra* note 18, at 62; and Fred L. Smith, Jr., *A Free-Market Environmental Program*, 11 CATO J. 457 (1992). For application and critique of this approach to the specific problem of climate change, see generally CLIMATE LIBERALISM, *supra* note 21.

other measures.[78] Competitive markets take advantage of the dispersed knowledge possessed by individuals about their own circumstances and subjective value preferences, as well as the availability of and demand for resources.[79] As a form of economic organization, markets facilitate the discovery and transmission of human needs and wants through prices.[80] This incentivizes efforts to meet such demands through the reallocation of resources and development of new technologies or techniques.[81]

Through the creation and dissemination of information, and the resulting economic incentives, markets create economic pressure for more efficient resource use, encourage technological and institutional innovations that reduce the adverse consequences of productive activity, and create incentives for firms to satisfy the environmental preferences of individuals—preferences that appear to increase as people become more wealthy.[82] One consequence of this dynamic has been the increasing abundance—indeed *super*abundance of natural resources.[83] Whereas fifty years ago, some feared that market consumption would exhaust natural resource supplies, leading to mass shortages and price spikes, we have witnessed quite the opposite.[84]

Cross-national studies have shown repeatedly that market-oriented economies do a better job of enhancing human welfare and meeting human needs.[85] Such societies are not only more prosperous, they also appear to do

---

78. *See* IAN VÁSQUEZ, MATTHEW D. MITCHELL, RYAN MURPHY & GUILLERMINA SUTTER SCHNEIDER, CATO INST. & FRASER INST., THE HUMAN FREEDOM INDEX 2024, at 12–14 (2024), https://www.cato.org/sites/cato.org/files/2024-12/2024-human-freedom-index.pdf [https://perma.cc/KPF4-ACML].

79. This is one of the central insights of F.A. Hayek. *See generally* F.A. Hayek, *The Use of Knowledge in Society*, 35 AM. ECON. REV. 519 (1945).

80. *See* Anderson, *supra* note 27, at 167 ("Prices arrived at through market transactions are a reflection of people's perceptions of scarcity and value. In a world where resource and environmental constraints are continually changing along with the value that people put on the environment, prices provide the necessary information to allow people to respond to dynamic natural and human conditions.").

81. *See* ANDERSON & LIBECAP, *supra* note 25, at 13 ("Property rights encourage innovation and entrepreneurial vision for discovering new rents when they are appropriable. Resources are discovered and, protected, and new uses are identified. Innovative management techniques are found and applied.").

82. Matthew E. Kahn & John G. Matsusaka, *Demand for Environmental Goods: Evidence from Voting Patterns on California Initiatives*, 40 J.L. & ECON. 137, 166–67 (1997). In this particular study, there is evidence that demand for some publicly provided environmental amenities does not continue to increase with income, perhaps due to the ability of wealthy to purchase such amenities privately. *Id.* at 166.

83. *See generally* MARIAN L. TUPY & GALE L. POOLEY, SUPERABUNDANCE (2022) (discussing the economic concept of "superabundance" as it relates to population growth and resource production).

84. *Id.* at 1–5; *see also* RONALD BAILEY, THE END OF DOOM: ENVIRONMENTAL RENEWAL IN THE TWENTY-FIRST CENTURY 31–73 (2015) (summarizing predictions about resource scarcity that were inaccurate).

85. *See* SHI-LING HSU, CAPITALISM AND THE ENVIRONMENT: A PROPOSAL TO SAVE THE PLANET 21 (2021) ("Just about *all* of the economic growth occurring in the history of humankind has occurred under capitalist systems . . . ."). *See generally* Joshua C. Hall & Robert A. Lawson, *Economic*

a better job at generating more positive environmental outcomes—at least where market institutions are established and allowed to operate.[86] Both economic growth rates and key measures of environmental quality are greater in countries where property rights are protected.[87] Greater protection of property rights correlates with a decline in deforestation as well as access to safe drinking water and sanitation services.[88] More broadly, higher levels of economic freedom continue to be associated "with better environmental and public health outcomes."[89] This is particularly true when the environmental record of market economies is compared with that of illiberal societies.[90]

Insofar as markets have not fully facilitated the achievement of environmental needs, the problem may not be in market institutions, as such, but in the failure to extend such institutions to incorporate environmental resources and values.[91] From this perspective, the role of government is not to identify and address each and every environmental impact of productive activity, but to provide and preserve the underlying institutional framework that protects the persons and property of individuals while extending such institutions so as to allow people to pursue and advance environmental values.

Looking around the world at how natural resources are managed, a general pattern emerges: As a general rule, where resources and environmental values are incorporated into market institutions through property rights and voluntary exchange protected by the rule of law, those resources tend to be better protected and are more likely to be utilized in a sustainable fashion.[92]

Freedom of the World: An Accounting of the Literature, 32 CONTEMP. ECON. POL'Y 1 (2014) (summarizing literature).

86. *See* RICHARD L. STROUP, ECO-NOMICS: WHAT EVERYONE SHOULD KNOW ABOUT ECONOMICS AND THE ENVIRONMENT 74–81 (2d ed. 2016).

87. *See* Seth W. Norton, *Property Rights, the Environment, and Economic Well-Being*, *in* WHO OWNS THE ENVIRONMENT? 37, 51 (Peter J. Hill & Roger E. Meiners eds., 1998).

88. *See* Carrie B. Kerekes, *Property Rights and Environmental Quality: A Cross-Country Study*, 31 CATO J. 315, 315, 320 (2011).

89. *See* Christopher Andrew Hartwell & Don L. Coursey, *Revisiting the Environmental Rewards of Economic Freedom*, 4 ECON. & BUS. LETTERS 36, 37 (2015); Norton, *supra* note 87, at 45 (noting that, insofar as environmental quality is viewed as a "good," "consumption" of environmental quality will increase as wealth increases).

90. The ecological record of socialist and communist countries is particularly bleak. *See* Peter J. Hill, *Environmental Problems Under Socialism*, 12 CATO. J. 321, 323 (1992); PAUL CRAIG ROBERTS & KAREN LAFOLLETTE, MELTDOWN: INSIDE THE SOVIET ECONOMY 32–35 (1990). *See generally* MURRAY FESHBACH & ALFRED FRIENDLY, JR., ECOCIDE IN THE USSR: HEALTH AND NATURE UNDER SIEGE (1992) (discussing the environmental and health effects of pollution in the USSR).

91. *See* Fred L. Smith, Jr., *The Market and Nature*, 43 FREEMAN 350, 351 (1993); *see also* Bruce Yandle, *Property Rights or Externalities?*, *in* PROPERTY RIGHTS: COOPERATION, CONFLICT, AND LAW 259, 260, 269–70, 274, 280 (Terry L. Anderson & Fred S. McChesney eds., 2003) (exploring whether environmental problems should be understood as resulting from market failures, such as externalities, or a failure to have property rights).

92. *See, e.g.*, Fred Smith, *Reappraising Humanity's Challenges, Humanity's Opportunities*, *in* THE TRUE STATE OF THE PLANET 379, 379, 389–91 (Ronald Bailey ed., 1995); Louis De Alessi, *Gains from Private Property: The Empirical Evidence*, *in* PROPERTY RIGHTS: COOPERATION, CONFLICT, AND

For example, privately owned forests exhibit higher rates of forest growth and tree planting than those managed by government agencies.[93] Similarly, private oyster beds tend to be healthier and more productive than their publicly managed counterparts.[94] There have also been economic and ecological gains from the development of markets in water through the recognition of transferable property rights and the adoption of market pricing.[95]

Perhaps the clearest evidence for the value of creating property rights in ecological resources comes from marine fisheries, where the adoption of property-based management has been shown to enhance sustainability.[96] A comprehensive survey of over eleven thousand fisheries around the globe found that the adoption of catch shares has a "dramatic impact" on fisheries collapse and concluded that their broader adoption could help fish stocks "recover substantially."[97] While such programs had been adopted for only about two percent of fish stocks as of 2010, they accounted for approximately twenty-five percent of the volume of fish caught.[98] Subsequent research has confirmed that the creation of property-based management systems encourages greater stewardship among fishery participants, including efforts

---

LAW, *supra* note 91, at 90, 90 (surveying empirical evidence on the benefits of property rights for resource management).

93. *See* Roger A. Sedjo & Douglas MacCleery, *Sustainable Forests in America?*, *in* PERSPECTIVES ON SUSTAINABLE RESOURCES IN AMERICA 22, 43 (Roger A. Sedjo ed., 2008) ("In recent decades tree planting has regularly exceeded 2 million acres annually, with the private sector accounting for roughly 87 percent of the tree planting in the United States."); Adler, *Free & Green: A New Approach to Environmental Protection*, *supra* note 77, at 672 ("While the U.S. is the world's greatest timber producer, it is also experiencing tremendous forest regrowth. . . . The lion's share of this regeneration is occurring on private land."); Jonathan H. Adler, *Poplar Front: The Rebirth of America's Forests*, *in* ECOLOGY, LIBERTY & PROPERTY: A FREE-MARKET ENVIRONMENTAL READER 65, 71 (Jonathan H. Adler ed., 2000) ("The vast majority of tree planting occurs on private land. While public property managers gain little financial benefit from sensible stewardship policies, the private property owner stands to lose or gain based on the quality of his or her management decisions."); Roger A. Sedjo, *Forests: Conflicting Signals*, *in* THE TRUE STATE OF THE PLANET, *supra* note 92, at 177, 178 ("In recent years, private forestlands have accounted for 85 percent of total tree planting and seeding in the United States."). Recent research also shows that net forest growth is greater in more developed nations. *See* Pekka E. Kauppi, Vilma Sandström & Antti Lipponen, *Forest Resources of Nations in Relation to Human Well-Being*, PLOS ONE, May 2018, at 1, 6 ("A significant positive correlation was observed between the rate of change of forest resources and the Human Development Index . . . showing expanding growing stock in high HDI countries.").

94. *See* Richard J. Agnello & Lawrence P. Donnelley, *Property Rights and Efficiency in the Oyster Industry*, 18 J.L. & ECON. 521, 532–33 (1975); Richard J. Agnello & Lawrence P. Donnelley, *Prices and Property Rights in the Fisheries*, 42 S. ECON. J. 253, 261 (1975).

95. *See* Jonathan H. Adler, *Water Rights, Markets, and Changing Ecological Conditions*, 42 ENV'T L. 93, 102–04 (2012); Morriss, *supra* note 26, at 988–90.

96. *See* Martin D. Smith, *The New Fisheries Economics: Incentives Across Many Margins*, 4 ANN. REV. RES. ECON. 379, 380 (2012) ("The story of fisheries economics could be distilled into diagnosing the commons problem and offering a solution to it.").

97. Christopher Costello, Steven D. Gaines & John Lynham, *Can Catch Shares Prevent Fisheries Collapse?*, 321 SCIENCE 1678, 1680 (2008).

98. Christopher Costello, John Lynham, Sarah E. Lester & Steven D. Gaines, *Economic Incentives and Global Fisheries Sustainability*, 2 ANN. REV. RES. ECON. 299, 300 (2010).

to maintain and enforce sustainable limits on the total catch.[99] Property rights have made fisheries more sustainable, even as population growth and economic development have increased demand for fish.

Property-based reforms have encouraged sustainable resource use and conservation. They have not been as widely successful at controlling pollution. In theory, the allocation and enforcement of property rights should fully internalize any potential externalities, the ubiquity of transaction costs makes this more of an aspiration than a reality.[100] While there are examples illustrating how well-defined and well-defended property rights could constrain pollution activity, it is not a principle that can be applied universally.[101] Empirical research suggests that where property rights are poorly defined or enforced, an increase in property rights protection can actually increase the pressure to dispose of wastes in unowned environmental commons.[102] Thus, increases in the security of property rights in land can correlate with increases in air pollution.[103] Market pressure for more efficient resource use contributed to pollution decline, but it is more difficult to attribute water and air quality improvements to the operation of property rights and markets.

Although there are few examples of broad property-based pollution control regimes,[104] markets may tend to reduce environmental impacts by constant pressures to increase efficiency. In the simplest of terms, market competition creates pressure for firms and individuals to minimize costs while maximizing output—to do more with less. Firms pay for the resources they consume and (where markets are robust and complete) for disposing of those resources they fail to use. This creates incentive to economize on all fronts. Over time, such pressures have led to a consistent decline in the material and

99. Trevor A. Branch, *How Do Individual Transferable Quotas Affect Marine Ecosystems?*, 10 FISH & FISHERIES 39, 42–43, 52–53 (2009); *see also* Jonathan H. Adler & Nathaniel Stewart, *Learning How to Fish: Catch Shares and the Future of Fishery Conservation*, 31 UCLA J. ENV'T L. & POL'Y 150, 191–97 (2013) (surveying research showing that property rights create incentives for fishers to operate with better efficiency and sustainability).

100. For a discussion of the strengths and weaknesses of common law litigation as a means of controlling pollution, see Jonathan H. Adler, *Is the Common Law a Free-Market Solution to Pollution?*, 24 CRITICAL REV. 61, 63–68 (2012).

101. *See, e.g.*, Elizabeth Brubaker, *The Common Law and the Environment: The Canadian Experience*, *in* WHO OWNS THE ENVIRONMENT?, *supra* note 87, at 87, 88–90; Julian Morris, *Climbing Out of the Hole: Sunsets, Subjective Value, the Environment, and the English Common Law*, 14 FORDHAM ENV'T L.J. 343, 349–54 (2003); ELIZABETH BRUBAKER, PROPERTY RIGHTS IN THE DEFENSE OF NATURE 171–78 (1995); *see also* Keith N. Hylton, *When Should We Prefer Tort Law to Environmental Regulation?*, 41 WASHBURN L.J. 515, 534 (2002) (arguing that property and nuisance law have advantages that could be applied to enforce environmental law).

102. *See* Kerekes, *supra* note 88, at 319, 334–36.

103. *Id.*

104. For a skeptical take on such approaches, see generally Daniel H. Cole, *Do Libertarians Have Anything Useful to Contribute to Climate Change Policy?*, *in* CLIMATE LIBERALISM, *supra* note 21, at 53 (arguing that climate policy must embrace complexity and nuance to effectively address climate change).

energy inputs required for a unit of economic output. Such gains come not only from increases in productive efficiency, but also from the discovery of new resources and the substitution of scarce resources with more readily available alternatives.[105]

These market pressures have helped produce what may be the most important (and least heralded) environmental trend of the twenty-first century: dematerialization.[106] What is now being observed represents a fundamental decoupling of resource consumption from economic growth, such that as mature economies grow, they not only use fewer resources per unit of output, but they also consume fewer resources overall, year over year.[107] The United States in particular "is post-peak in its exploitation of the earth."[108] Consumption of all but six of the seventy-two resources tracked by the U.S. Geological Survey are declining, even as the economy continues to grow.[109] Market-driven growth increasingly correlates with declining material consumption. Put simply, "capitalism and tech progress are now allowing us to tread more lightly on the earth instead of stripping it bare."[110]

Consider that the first aluminum beer cans, introduced in the 1950s, weighed eighty-five grams. By 2011, however, the average can weighed less than thirteen grams.[111] Put another way, there is now as much metal in seven such cans as there used to be in one. Cans today are not only thinner and lighter, they are produced more efficiently, with fewer separate sheets of metal. Such changes were driven by the simple desire to discover ways to do more with less in a competitive market.

Substitution can be an even more powerful source of dematerialization. Consider telecommunications. A single fiber optic cable made from less than one hundred and fifty pounds of silica can carry the same volume of information as multiple one ton copper cables.[112] This not only represents dramatic dematerialization, it also reduces other environmental impacts as well as obtaining the sand necessary for fiber optics is far less energy intensive and environmentally disruptive than mining and smelting copper. The

105. As McAfee notes, the "combination of self-interest and innovativeness" results in "a wide-ranging search for more of the resource, and an equally ardent search for substitutes." MCAFEE, *supra* note 61, at 70.

106. *See* Lynn Scarlett, *Doing More with Less: Dematerialization—Unsung Environmental Triumph?*, *in* EARTH REPORT 2000: REVISITING THE TRUE STATE OF THE PLANET 41, 48–55, 60–61 (Ronald Bailey ed., 2000).

107. *See* MCAFEE, *supra* note 61, at 77.

108. *Id.* at 1.

109. *Id.* at 82–83. The six resources for which consumption is not declining year over year are diatomite, industrial garnet, gemstones, salt, silver, and vanadium. *Id.* at 83 n.*. Consumption of plastics have also not yet declined. *Id.* at 83.

110. *Id.* at 4.

111. VACLAV SMIL, MAKING THE MODERN WORLD: MATERIALS AND DEMATERIALIZATION 123 (2014); MCAFEE, *supra* note 61, at 101.

112. *See* Scarlett, *supra* note 106, at 51.

dematerialization of telecommunications did not stop there, however. Satellite and wireless technologies enable us to bypass the use of physical cables altogether. We can communicate more and yet use vastly less material to do so. This not only saves copper, but other resources too. Think of all the paper saved by e-mail, e-banking, e-readers, and smartphones.[113] The point is not that these new technologies do not require resources or impose environmental costs, for like all human activity, of course they do. The point is that these technological changes, driven by competitive pressures in a relatively free market, have led to dramatic dematerialization and a lessening of the associated environmental impacts of meeting the world's telecommunication needs.[114]

What the world has experienced—and is still experiencing—in the telecommunications sector is the sort of transformation needed in the energy sector: a dramatic reduction in the consumption of material inputs—in the case of energy, carbon—and the associated environmental impacts. Robust market institutions, not regulatory mandates, are what make this sort of transition possible. No government agency decreed that copper wire would be replaced by fiberoptics, or that fiber optics would, in turn, be replaced by wireless transmission. The challenge is to identify where market institutions are incomplete, and where existing incentives are inadequate, and adopt appropriate remedial measures.

III. CLIMATE LIBERALISM

Dematerialization provides a roadmap for decarbonization. By more fully incorporating carbon into the market, so as to ensure that those who consume carbon-based fuels and use portions of the atmosphere for carbon disposal must bear those costs, it is possible to replicate the same sorts of incentives that have produced dematerialization. If such incentives are insufficient, they can be further supplemented with technology-inducement prizes for low-carbon technologies and the use of procurement policies to facilitate market-driven deployment of decarbonizing technologies. But such market-driven innovation and deployment can also only happen if markets are allowed to operate—if markets are sufficiently unregulated in the relevant spaces so that innovators, entrepreneurs, and others can develop and deploy decarbonizing technologies.

As noted above, decarbonization lags behind dematerialization because users of carbon-based fuels do not pay to dispose of the carbon they emit.[115]

---

113. MCAFEE, *supra* note 61, at 113. McAfee notes that paper consumption in the United States peaked in 1990. *Id.*

114. While dematerialization can reduce associated environmental impacts, it does not wholly eliminate the environmental impacts of associated activities, including in the context of telecommunications. Technological progress may make it possible to reduce environmental impacts over time, but it does not eliminate all such impacts.

115. *See supra* notes 100–14 and accompanying text.

It is tremendously expensive, given current technologies, for firms to collect and sequester the carbon dioxide generated by the combustion of fossil fuels.[116] Emitting the carbon dioxide into the global atmosphere, on the other hand, is free. Because it is unowned, emitters need not compensate anyone for their emissions. The global atmosphere is the ultimate open-access commons.[117]

Creating greater incentives to decarbonize, without erecting barriers to innovation or technological deployment, can be achieved through the imposition of a carbon tax. Such a tax could be conceptualized as a user fee on the use of the common atmosphere for carbon disposal, or even as an effort to "internalize" the "externalities" of greenhouse gas emissions.[118] However it is conceptualized, placing a fee on the emission of carbon dioxide would make existing energy markets more competitive in ways that would encourage greater conservation and innovation than do existing regulatory alternatives.[119]

While carbon taxes are often unpopular, existing evidence suggests they are more effective at driving down carbon emissions than other policies.[120] One reason for this efficacy is that, unlike proscriptive regulations, carbon taxes create an incentive without creating specific requirements for how the

---

116. *See* Edmonds et al., *supra* note 56 (discussing costs of carbon capture with current technologies).

117. *See generally* Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1968). Note that Hardin was not the first to note the nature of commons problems, but he did effectively popularize the notion. When Hardin wrote, the commons problem was well understood by resource economists, particularly those researching fisheries. *See, e.g.*, H. Scott Gordon, *The Economic Theory of a Common-Property Resource: The Fishery*, 62 J. POL. ECON. 124, 124 (1954); Anthony Scott, *The Fishery: The Objectives of Sole Ownership*, 63 J. POL. ECON. 116, 116 (1955). They did not discover this problem either. The general phenomenon was identified much earlier, including by Aristotle. *See, e.g.*, ARISTOTLE, POLITICS 57 (Benjamin Jowett trans., 1920) (c. 336 B.C.E.).

118. For a sampling of arguments in favor of carbon taxes from various ideological perspectives, see generally Bob Inglis & Arthur B. Laffer, Opinion, *An Emissions Plan Conservatives Could Warm To*, N.Y. TIMES (Dec. 27, 2008), https://www.nytimes.com/2008/12/28/opinion/28inglis.html (on file with the *Iowa Law Review*); James Hansen, Opinion, *Cap and Fade*, N.Y. TIMES (Dec. 6, 2009), https://www.nytimes.com/2009/12/07/opinion/07hansen.html (on file with the *Iowa Law Review*); George P. Shultz & Gary S. Becker, *Why We Support a Revenue-Neutral Carbon Tax*, WALL ST. J. (Apr. 7, 2013, 6:13 PM), https://www.wsj.com/articles/SB10001424127887323611604578396401965799658 (on file with the *Iowa Law Review*); Ed Dolan, *A Classical Liberal Case for Target-Consistent Carbon Pricing*, *in* CLIMATE LIBERALISM, *supra* note 21, at 291; Mark Budolfson, *The Social Cost of Carbon, Humility, and Overlapping Consensus on Climate Policy*, *in* CLIMATE LIBERALISM, *supra* note 21, at 335.

119. Stechemesser et al., *supra* note 1, at 891 ("In line with theoretical expectations, we have identified pricing as a particularly effective policy in those sectors dominated by profit-maximizing firms—namely, industry—but also the electricity sector in developed economies.").

120. *Id.* at 889 (Carbon taxation "stands out as the only policy instrument that achieves near equal or larger effect size as a stand-alone policy across all sectors"); *see also* Mort Webster, Karen Fisher-Vanden & Ian Sue Wing, *The Economics of Power System Transitions*, 18 REV. ENV'T. ECON. & POL'Y 66, 68 (2024) ("In the United States, political opposition to CO_2 pricing has given rise to a policy architecture of second-best instruments that mandate specific technologies . . . .").

incentive is addressed. Taxes increase the price of the taxed item, generating economic pressure to reduce consumption, but do not dictate the margin on which such reductions occur.[121] Thus the imposition of such a tax may encourage energy conservation or efficiency enhancements within firms.[122] Yet, such taxes can also induce other changes, such as fuel switching or the restructuring of industrial processes.[123] Indeed, the imposition of a tax places no limit on the ways in which its costs can be avoided, leaving firms and individuals free to innovate ways of doing more with less.[124] Carbon taxes are also easier to implement than regulatory alternatives and are less vulnerable to legal challenge.[125]

In theory, there is not much difference between a pollution tax and a tradable emission credit regime.[126] This is because a supply limitation can operate as a tax, and vice-versa. In practice, however, the two programs are not equivalent. Among other things, policymakers lack the necessary information to know what tax level would be equivalent to what supply constraint, but this is hardly the only difference. Another meaningful difference is that implementation of a cap-and-trade regime requires many more decisions about regulatory design than a tax regime, and each decision

---

121. *See* HSU, *supra* note 85, at 42 (discussing the role of prices).

122. Hoppe et al., *supra* note 3, at 622 ("Most of the emissions reductions attributed to carbon pricing schemes appear to be the result of low-cost operational measures that are relatively easy to implement and thus produce immediate emission reductions.").

123. *See id.*

124. For interesting examples of bottom-up innovations that can have broad environmental impacts, see TODD MYERS, TIME TO THINK SMALL: HOW NIMBLE ENVIRONMENTAL TECHNOLOGIES CAN SOLVE THE PLANET'S BIGGEST PROBLEMS 25–29 (2022).

125. *See* Adler, *supra* note 49, at 10495–96.

126. *See* TOL, *supra* note 5, at 53; HSU, *supra* note 85, at 117–19. It is worth noting that while so-called "cap-and-trade" systems, such as that which was used for sulfur-dioxide emissions under the 1990 Clean Air Act, may treat emission credits as a form of tradable property, any resulting emission reductions are more attributable to the cap on aggregate emissions than they are to the protection of property rights from harm caused by pollution. *See* Byron Swift, *How Environmental Laws Work: An Analysis of the Utility Sector's Response to Regulation of Nitrogen Oxides and Sulfur Dioxide Under the Clean Air Act*, 14 TUL. ENV'T L.J. 309, 315 (2001) (noting that the emissions cap is "the most important element" of a cap-and-trade scheme "because it establishes the program's environmental integrity").

It is also interesting to note that some of the economists who first developed this approach to pollution control believe it is inapplicable to climate change. *See* Jon Hilsenrath, *Cap-and-Trade's Unlikely Critics: Its Creators*, WALL ST. J. (Aug. 13, 2009, 11:59 PM), https://www.wsj.com/articles/SB125011380094927137 (on file with the *Iowa Law Review*).

presents the opportunity for rent-seeking behavior.[127] As a result, carbon taxes "pose fewer issues with administrability."[128]

Given political constraints, it is unlikely a carbon tax would be adopted that fully captures all of the costs associated with GHG emissions.[129] Even a properly calculated tax might not create sufficient incentives for the development of decarbonizing technologies and other innovations.[130] One policy that could help fill this gap would be the creation of technology inducement prizes to reward the invention and development of needed technological breakthroughs.[131] One reason prizes would be superior to traditional research and development grants is that they do not seek to predict which experiments, theories, or prototypes will lead to desirable innovation, and thus they do not depend upon centralized knowledge or effective prognostication. Rather, like markets themselves, they reward those who come up with previously undiscovered ways of meeting identified wants—in this case, the wants specified in the prize parameters. As such, they seek to capitalize and augment market dynamics and recognize the nature of breakthrough innovation is that it is unanticipated or unplanned. In effect, government funded prizes of this sort can be understood as efforts to subsidize the production of public goods through market processes, rather than through direct government provision.

While a carbon tax and technology inducement prizes could spur needed decarbonizing innovations, even the most miraculous breakthroughs will do little to address climate change if they cannot be deployed. For this reason, it is also important to unshackle constraints on markets that inhibit the development and deployment of decarbonizing technologies. One reason that the market forces driving decarbonization have been so powerful and

---

127. *See* Reuven S. Avi-Yonah & David M. Uhlmann, *Combating Global Climate Change: Why a Carbon Tax Is a Better Response to Global Warming than Cap and Trade*, 28 STAN. ENV'T L.J. 3, 37–39 (2009) (explaining why a tradable emission permit regime is inherently more complex than an equivalent carbon tax regime); Michael J. Waggoner, *The House Erred: A Carbon Tax Is Better than Cap and Trade* 1259–60 (U. Colo. L. Legal Stud. Rsch. Paper, No. 09-18, 2009), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1489592 [https://perma.cc/H36U-YDNX].

128. Shi-Ling Hsu, *Prices Versus Quantities*, *in* POLICY INSTRUMENTS IN ENVIRONMENTAL LAW 183, 195 (Kenneth R. Richards & Josephine van Zeben eds., 2020).

129. There are also serious questions about whether the proper level of a tax could be calculated. For a discussion of current estimates of the costs of climate change and associated carbon price that would reflect such costs, see generally Richard S.J. Tol, *A Meta-Analysis of the Total Economic Impact of Climate Change*, 185 ENERGY POL'Y, Feb. 2024, https://www.sciencedirect.com/science/article/pii/S0301421523005074 [https://perma.cc/ME9L-SH9Z] (showing a range of estimates from -$355 per ton of carbon to $587 per ton of carbon, with a weighted average of $59 per ton).

130. *See* Popp, *supra* note 20, at 51 ("[H]igher energy prices alone are not sufficient to fully support low-carbon energy innovation.").

131. For an extended argument in favor of such prizes, see generally Adler, *supra* note 70. *See also* HSU, *supra* note 85, at 191–92 (listing examples of prizes, such as from Sir Richard Branson and the U.S. Department of Energy).

effective is that much of the relevant innovation is not constrained by prescriptive regulations and permitting requirements. Many energy technologies, on the other hand, are mired in regulatory constraints that delay deployment, inhibit investment, and discourage the development of needed technologies. Promising projects, such as a proposed wind energy facility on Lake Erie, are left stillborn.[132] Something as straightforward, and essential, as permitting the transmission lines necessary for low-carbon power sources to be utilized can take a decade.[133] No less important, the prospects of delay—and the resulting uncertainty about whether investments will ever generate a return—discourages some from even starting.[134] Thus, permitting reform, and other measures designed to unleash market forces that can drive decarbonization, are a necessary part of meeting climate goals.[135]

While the bulk of this Essay has focused on mitigation—how to reduce GHG concentrations in the atmosphere—climate adaptation measures will be important too.[136] Here, again, markets have much to offer.[137] Where private markets are able to respond to observed and projected changes caused by climate change, they will do so more effectively and efficiently than centralized administrative agencies.[138] In the case of water, for example, facilitating water reallocation through markets and water conservation through

132. In the case of Icebreaker Wind, planned for Lake Erie, it took from 2007 to 2023 for the project to be effectively canceled. *See* Jonathan H. Adler, Permitting the Future 8 (July 23, 2024) (unpublished manuscript) (on file with the *Iowa Law Review*). Unfortunately, this was hardly an isolated example. *See* Alexandra B. Klass & Rebecca Wilton, *Local Power*, 75 VAND. L. REV. 93, 156 (2022) ("[L]ocal governments [commonly] restrict[] or ban[] rooftop solar, wind farms, and other critical energy projects needed to address climate change and support a clean energy transition.").

133. *See* Michael B. Gerrard, *A Time for Triage*, 39 ENV'T F., Nov.–Dec. 2022, at 38, 40 ("The average approval time for new transmission lines (without which many wind and solar farms are useless) now exceeds 10 years."); BRIAN POTTER, INST. FOR PROGRESS, HOW TO SAVE AMERICA'S TRANSMISSION SYSTEM 9 (2024) ("Transmission lines, for instance, take on average [ten] years to build in the [United States], and in some cases can take up to [twenty] years.").

134. Mario Loyola, *Cut the Red Tape*, 39 ENV'T F., Nov.–Dec. 2022, at 30, 36 (noting "uncertainty" is the greatest "source of risk to capital formation" in support of renewable energy projects).

135. *See* ADAM THIERER, PERMISSIONLESS INNOVATION: THE CONTINUING CASE FOR COMPREHENSIVE TECHNOLOGICAL FREEDOM 5 (rev. & expanded ed. 2016) ("[T]he general freedom to experiment with new and better ways of doing things is essential for powering the next great wave of industrial innovation and rejuvenating our dynamic, high-growth economy.").

136. *See* TOL, *supra* note 5, at 118 (noting that because not all effects of climate change can be avoided, some amount of adaptation will be necessary).

137. *See generally* Robert Mendelsohn, *The Role of Markets and Governments in Helping Society Adapt to a Changing Climate*, 78 CLIMATIC CHANGE 203 (2006) (discussing how markets and governments may provide an avenue to address climate change); ADAPT AND BE ADEPT: MARKET RESPONSES TO CLIMATE CHANGE (Terry L. Anderson ed., 2021) (discussing the comparative advantages of adaptation when considering market and government realities).

138. *See generally* MATTHEW E. KAHN, ADAPTING TO CLIMATE CHANGE: MARKETS AND THE MANAGEMENT OF AN UNCERTAIN FUTURE (2021) (arguing market actors should work toward adaptation in the private sector).

market pricing will do more to address the dynamic changes wrought by climate change than administrative planning or infrastructure construction.[139]

It is also important that government policies not inhibit the transmission of accurate market signals about climate change threats and impacts. Subsidies to development in coastal areas, for instance, discourage market responses to the threat of increased coastal damage from hurricanes and tropical storms. Regulations on the development and use of various risk instruments can likewise inhibit proper risk management.[140] Limitations on liability for identifiable contributions to climate change risks inhibit the proper market responses to tort liability.[141] Limitations on such litigation will also impair efforts to identify and defend property interests that are potentially harmed by climate change. Climate attribution is difficult, but one way it will get better will be through allowing entrepreneurial plaintiffs lawyers to experiment and innovate and invest in improvements in attribution.[142]

CONCLUSION

Stabilizing atmospheric concentrations of GHGs as a means of addressing climate change is a daunting challenge. It is a challenge for which the conventional approach to environmental regulation is unfit.

The traditional regulatory model of environmental protection is a "failing paradigm."[143] At the turn of the last century it was recognized that this approach would be "inadequate for the challenges" of the twenty-first century.[144] Analysts at Resources for the Future concluded this approach "is deeply and fundamentally flawed."[145] Even the Clinton–Gore Administration recognized the limitations of prescriptive regulations, including their potential to "discourage technological innovation."[146] These assessments were made in the 1990s, and since then Congress has done nothing to meaningfully change

139. *See* Adler, *supra* note 95, at 95, 109–10; Jonathan H. Adler, *Water Marketing as an Adaptive Response to the Threat of Climate Change*, 31 HAMLINE L. REV. 729, 739 (2008).

140. *See* Andrew P. Morriss, *Market Solutions to Large Number Environmental Problem-Induced Changes in Risk Distributions*, *in* CLIMATE LIBERALISM, *supra* note 21, at 251, 253–54.

141. For a "conservative" defense of climate litigation, see Brian T. Fitzpatrick, *Climate Change and Class Actions*, *in* CLIMATE LIBERALISM, *supra* note 21, at 183, 186 & n.6, 192–93.

142. On the role of tort litigation as a potential discovery mechanism in the climate change context, see Catherine M. Sharkey, *Common Law Tort as a Transitional Regulatory Regime: A New Perspective on Climate Change Litigation*, *in* CLIMATE LIBERALISM, *supra* note 21, at 103, 106–07, 110.

143. *See generally* Stewart, *supra* note 28 (describing the U.S. environmental regulation paradigm as failing to provide efficient, cost-effective protection, necessitating transformative reforms to address future challenges and international implications).

144. Karl Hausker, *Reinventing Environmental Regulation: The Only Path to a Sustainable Future*, 29 ENV'T L. REP. NEWS & ANALYSIS 10148, 10149 (1999).

145. J. CLARENCE DAVIES & JAN MAZUREK, REGULATING POLLUTION: DOES THE U.S. SYSTEM WORK? 2 (1998).

146. BILL CLINTON & AL GORE, REINVENTING ENVIRONMENTAL REGULATION 2 (1995), https://nepis.epa.gov/Exe/ZyPDF.cgi/9100TH76.PDF?Dockey=9100TH76.PDF [https://perma.cc/5DAA-JE68].

or reform the fundamental architecture of federal environmental regulation—let alone enact meaningful measures to address the threat of climate change.[147]

Wholesale decarbonization requires revolutionary changes through the economy and the development of technologies and innovations that can be deployed throughout the world. This is not something that can be mandated or planned, nor is it something that will happen without policies designed to take advantage of dynamic market processes and their potential to drive transformational change.[148] As Vaclav Smil cautions, "we are a fossil-fueled civilization whose technical and scientific advances, quality of life, and prosperity rest on the combustion of huge quantities of fossil carbon, and we cannot simply walk away from this critical determinant of our fortunes in a few decades, never mind years."[149]

"U.S. climate policy is a mess."[150] Only a wholesale rethinking of our approach to environmental protection that accounts for the wickedness of climate change and the power of market institutions to induce change will be sufficient to get things right.

147. Pappas, *supra* note 6, at 352 ("The federal legislature has been inactive regarding emissions regulation in that it has neither passed new statutes addressing emission regulation nor has it updated relevant existing statutes, such as the federal Clean Air Act.").

148. *See* HSU, *supra* note 85, at xiii ("One of the few forces capable of making profound change in a short period of time is capitalism.").

149. *See* SMIL, *supra* note 7, at 5.

150. Pappas, *supra* note 6, at 348.